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Bae et al.

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(54) **SOUND APPARATUS**

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H04R 1/02 (2006.01)

(52) **U.S. Cl.**
CPC ***H04R 1/026*** (2013.01)

(58) **Field of Classification Search**
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See application file for complete search history.

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(57) **ABSTRACT**

A sound apparatus is disclosed. The sound apparatus includes a body, a bracket coupled to a lower portion of a rear surface of the body, a plurality of upper links, one end of each of the upper links being hinge-coupled to the bracket, a middle frame hinge-coupled to the other end of each of the upper links, a plurality of lower links, one end of each of the lower links being hinge-coupled to the middle frame, and at least one speaker module hinge-coupled to the other end of each of the lower links to vertically move according to rotational movement of the upper links and the lower links, wherein a direction of rotation of the upper link is opposite to a direction of rotation of the lower links, and the middle frame moves in a lateral direction during the rotational movement of the upper links and the lower links.

17 Claims, 16 Drawing Sheets

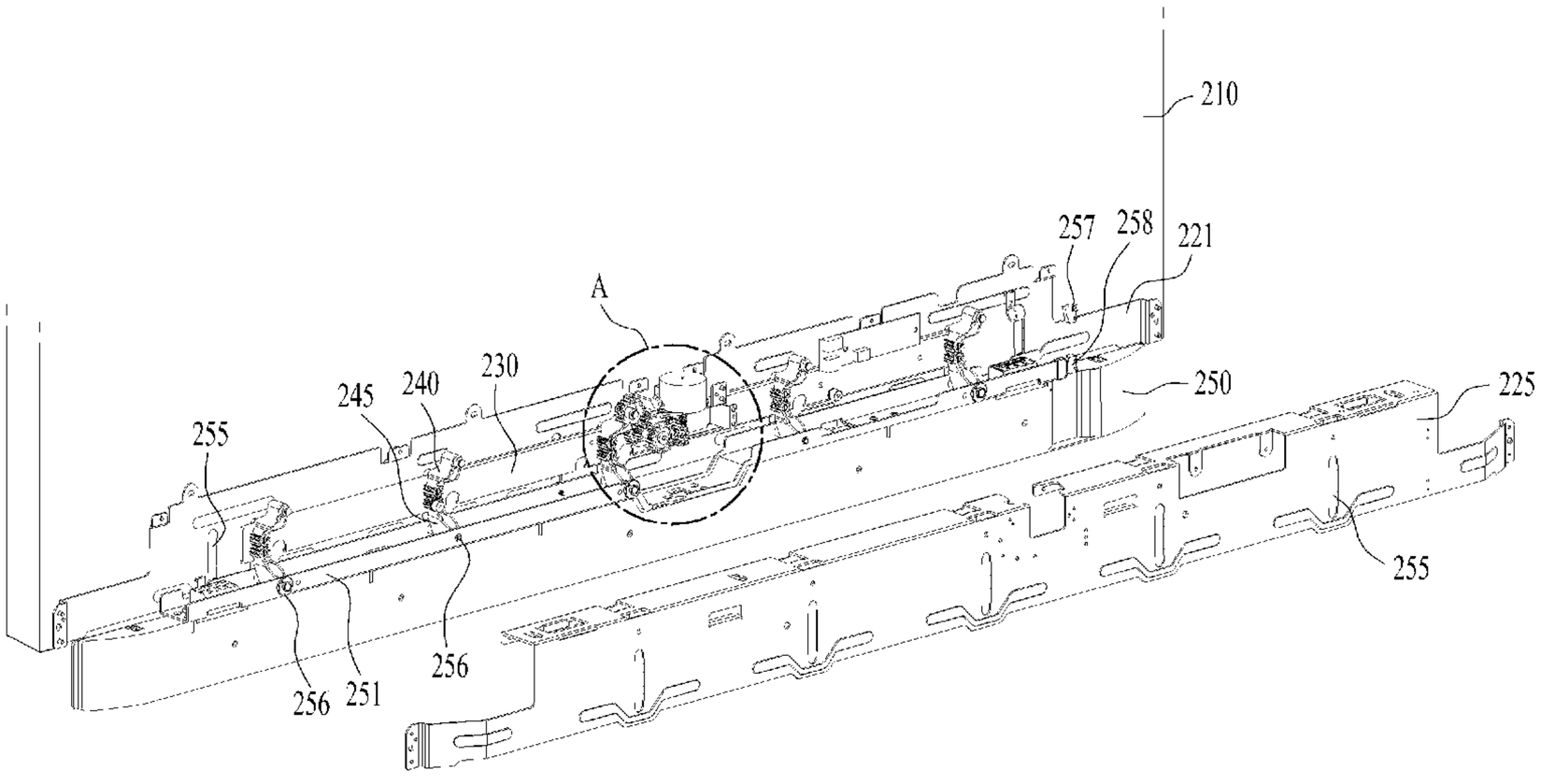

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FIG. 1

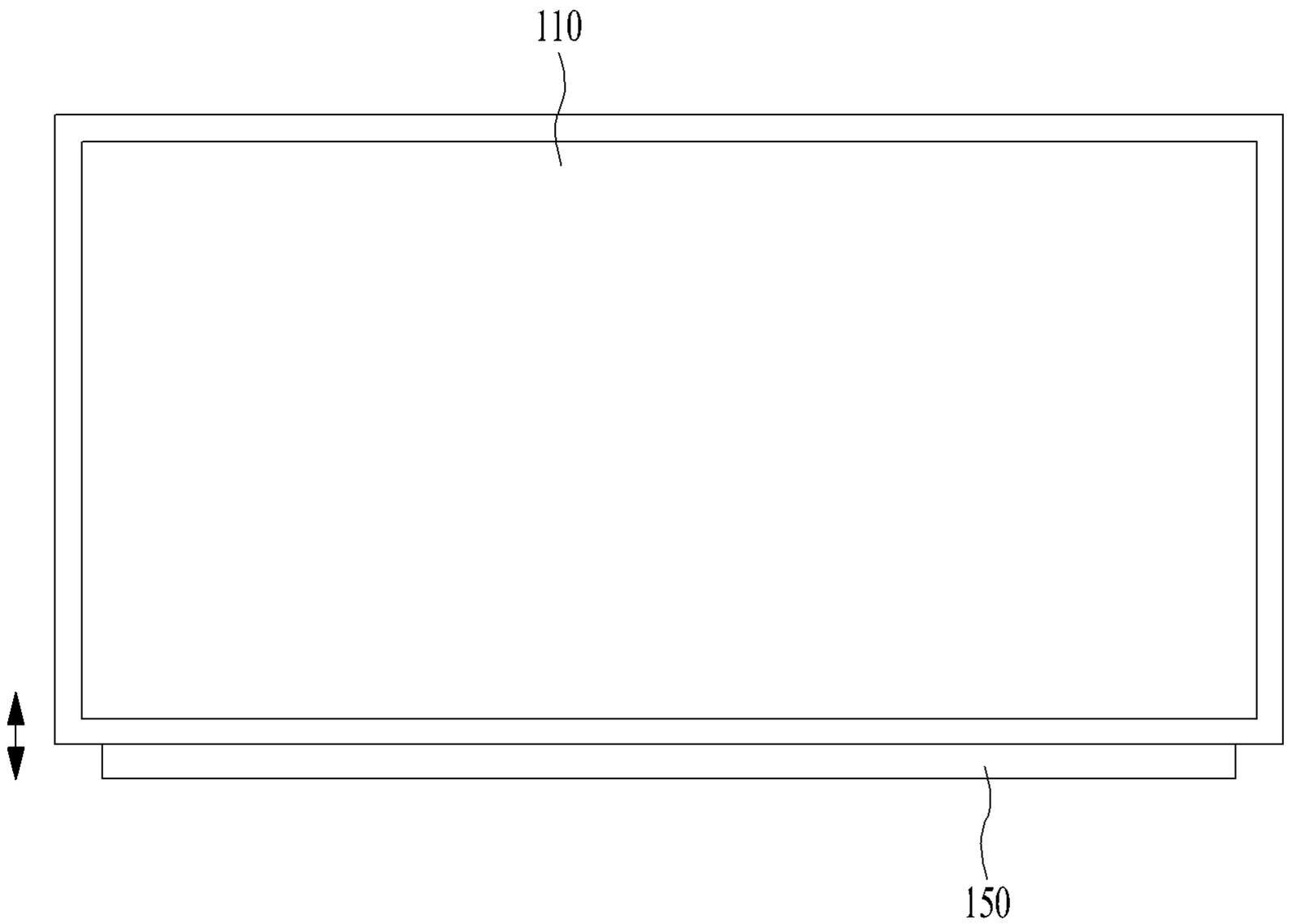


FIG. 2

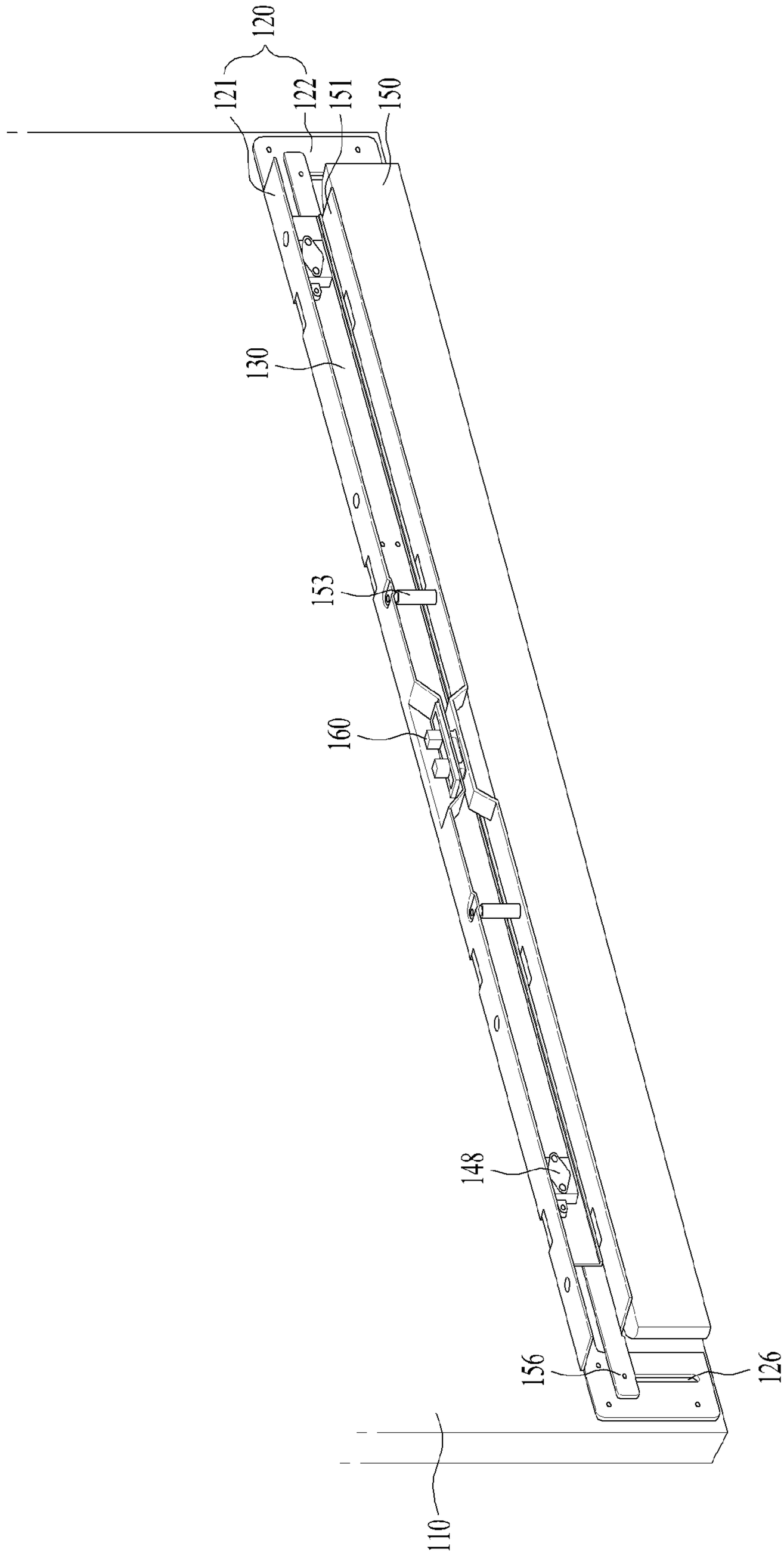


FIG. 3

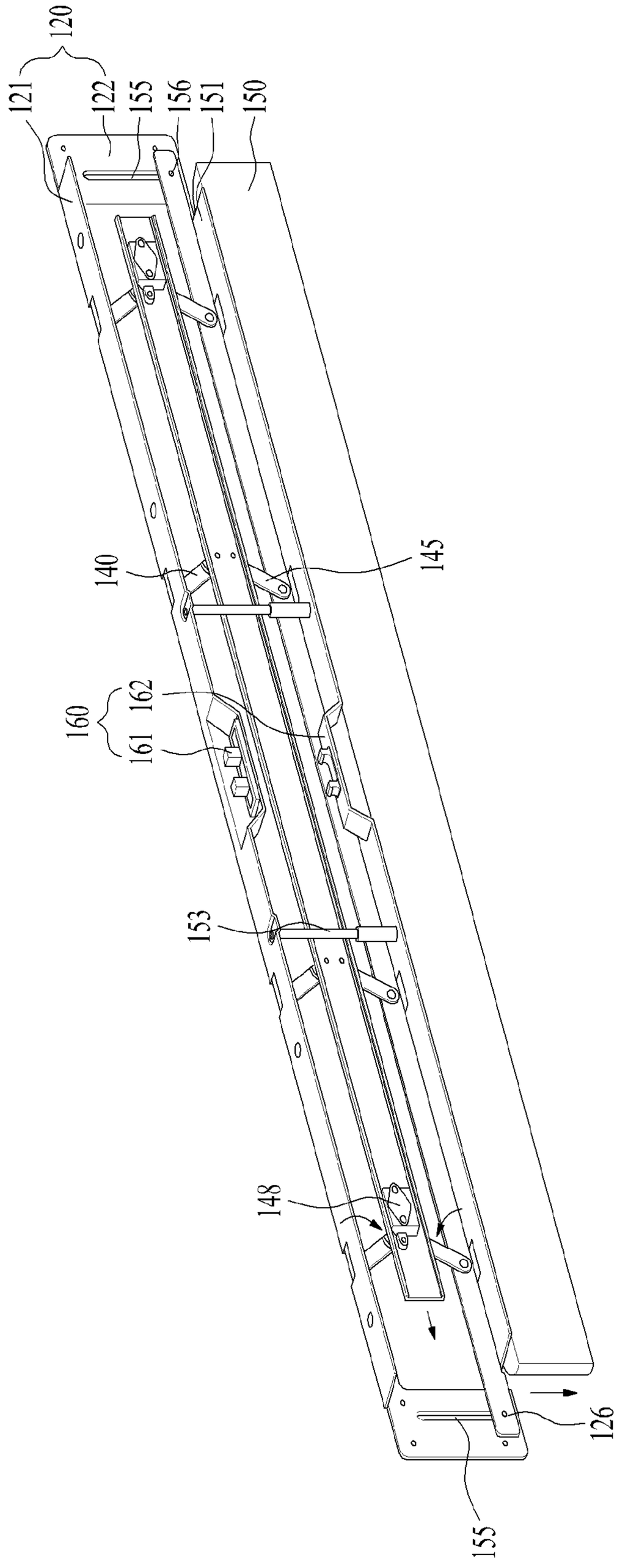


FIG. 4

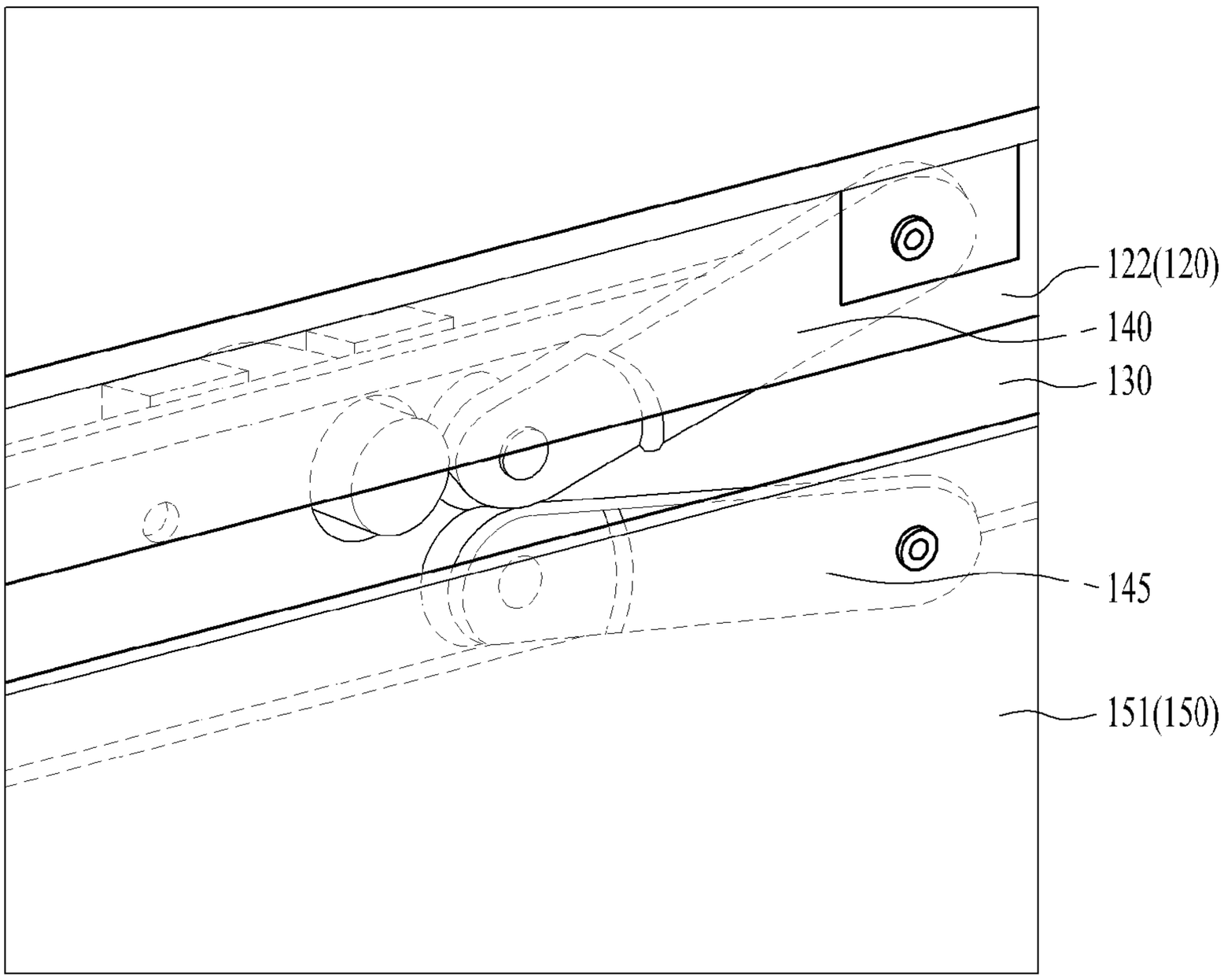


FIG. 5

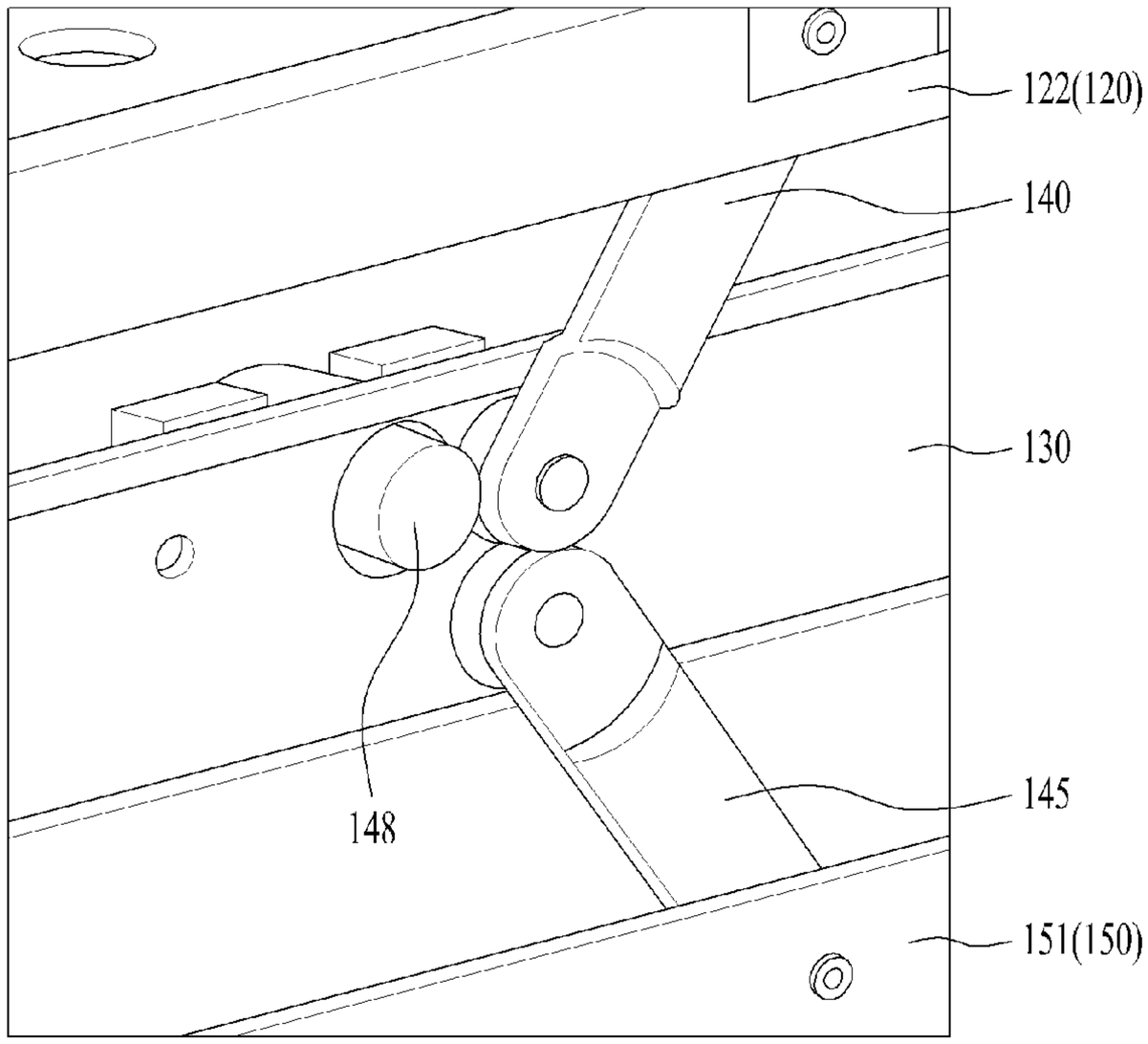
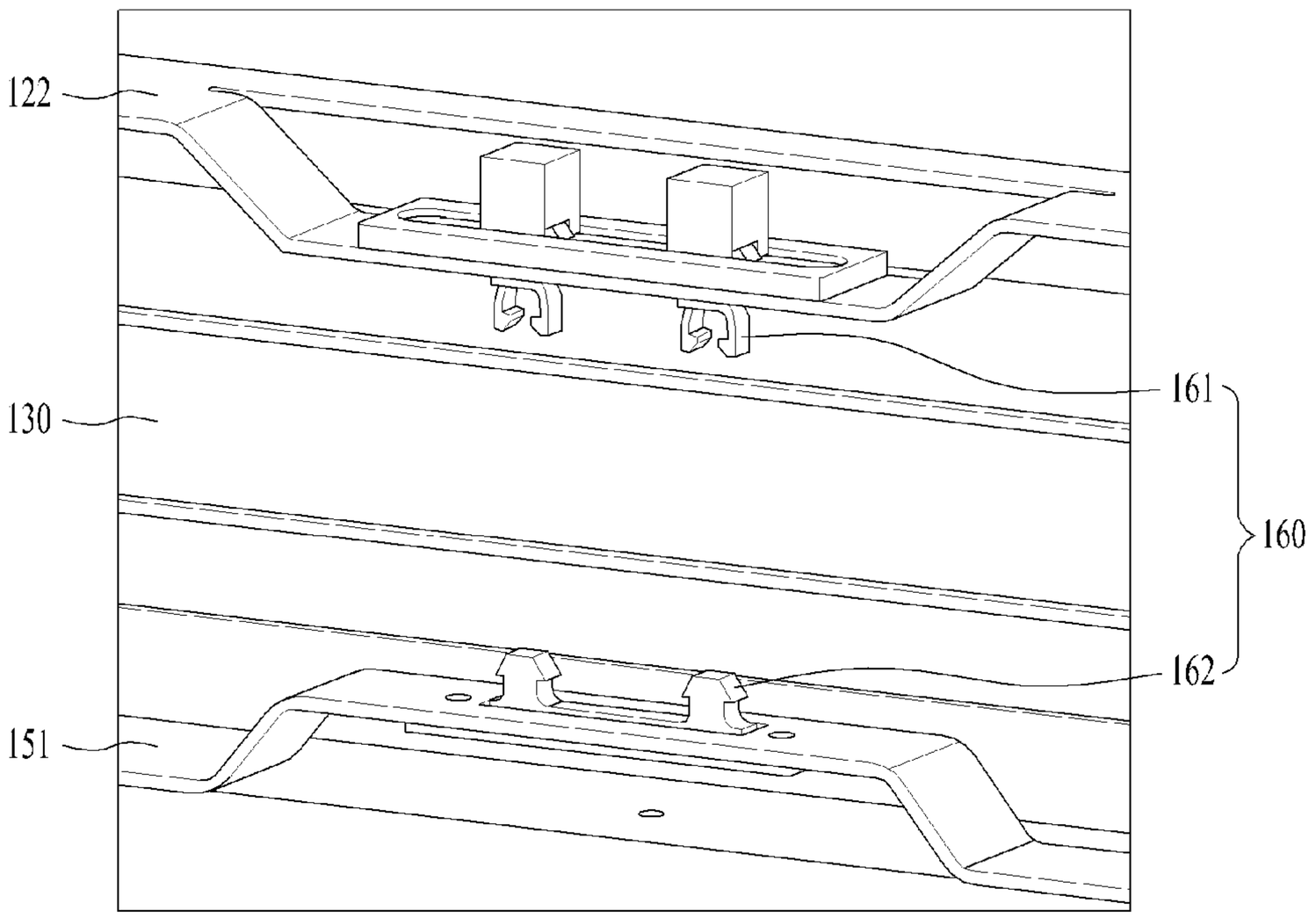


FIG. 6



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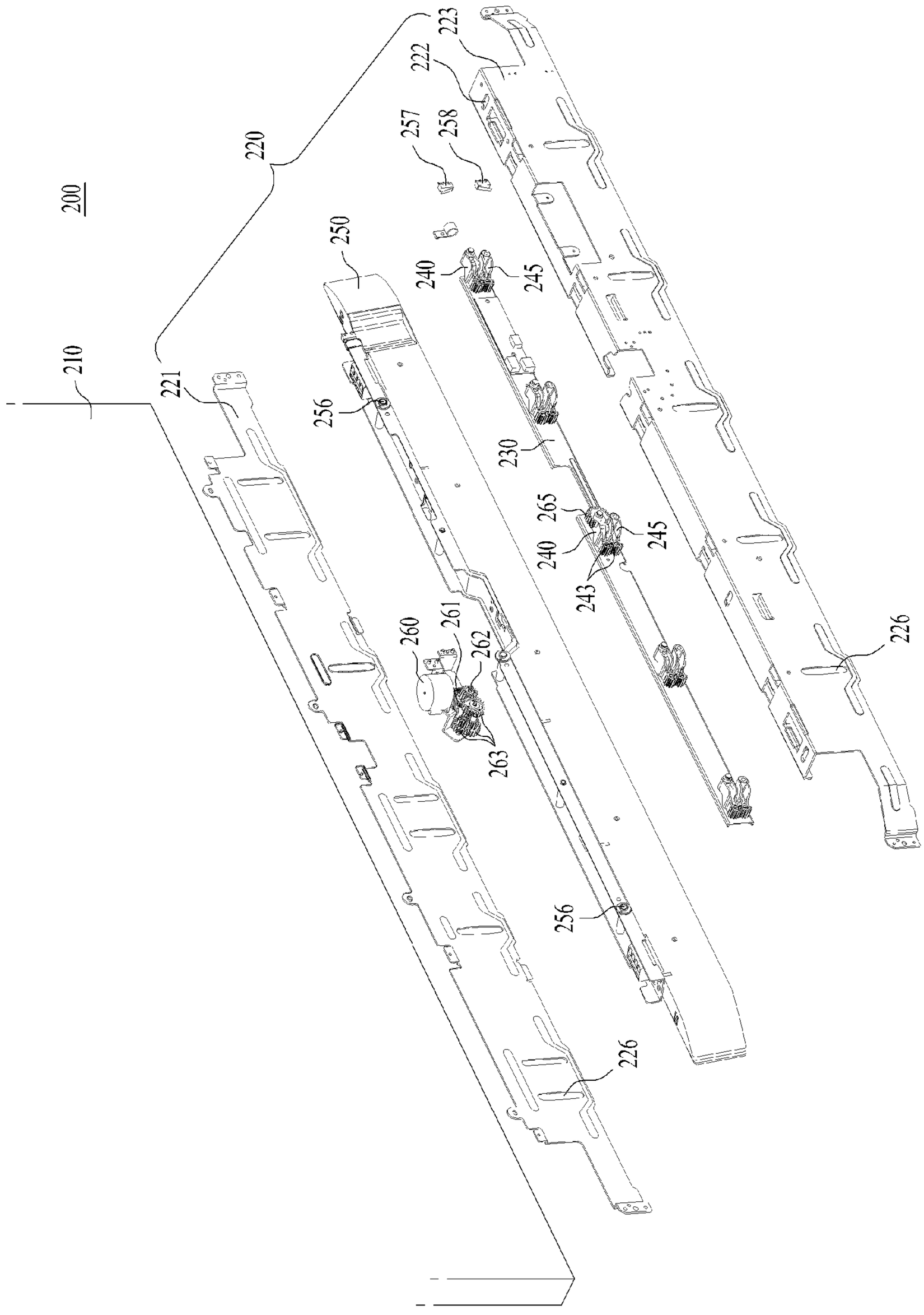
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FIG. 8

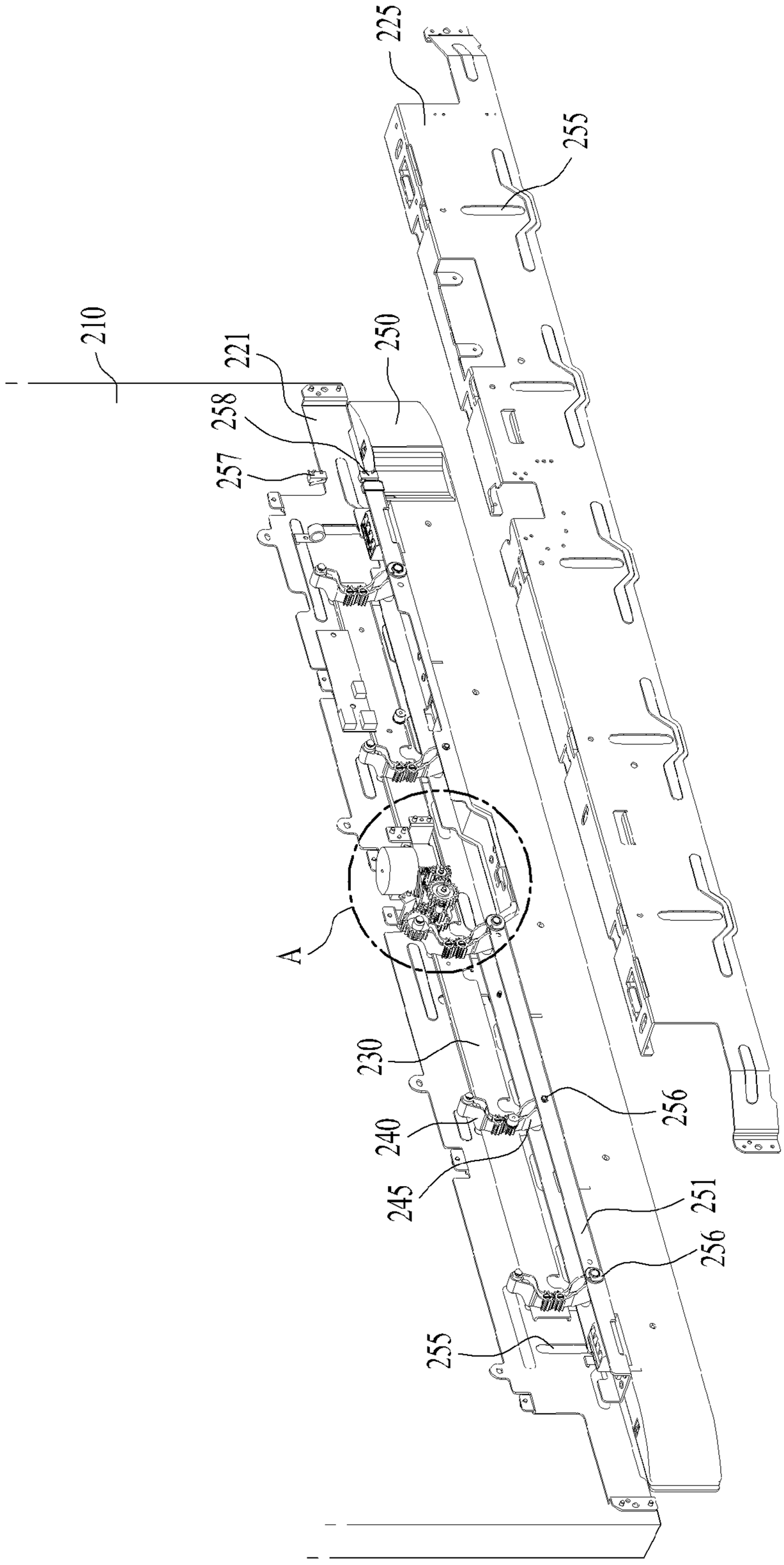

FIG. 9

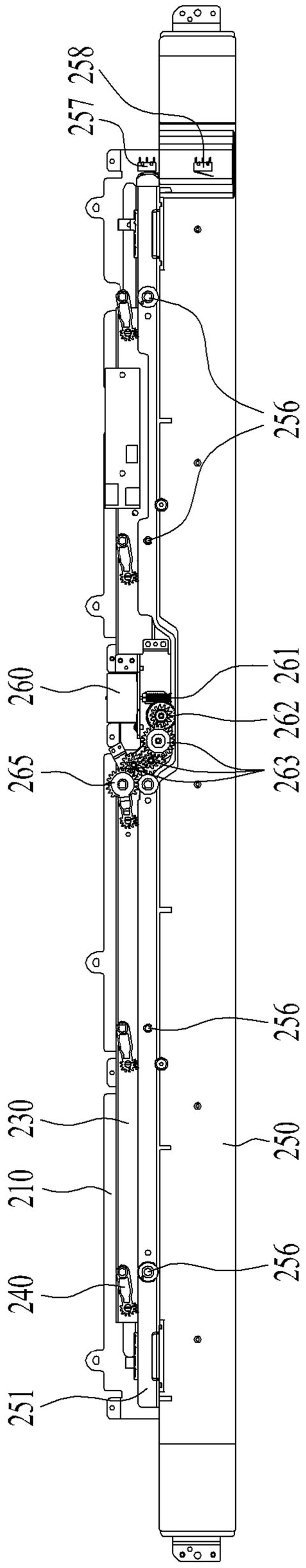

FIG. 10

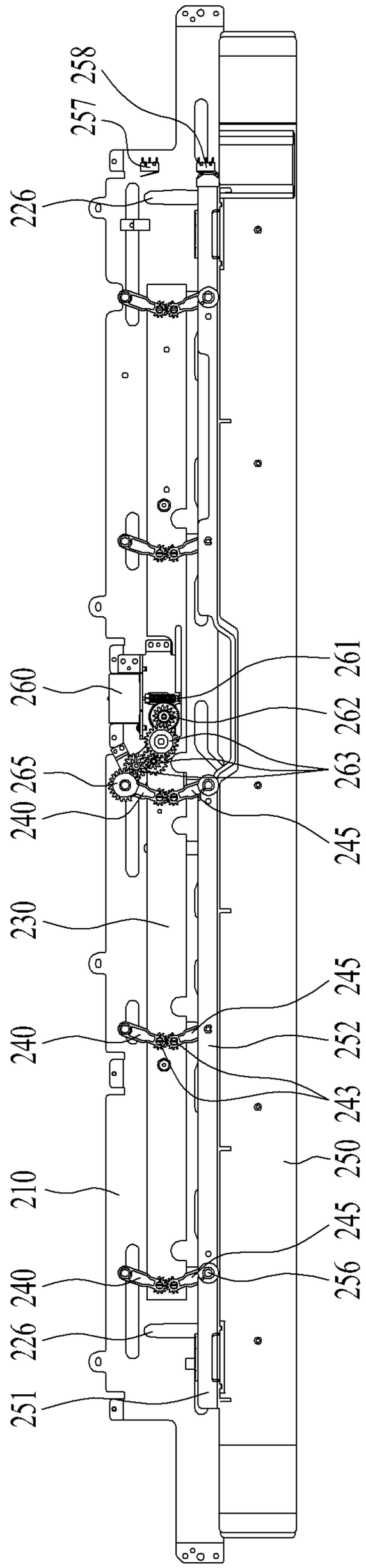
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FIG. 11

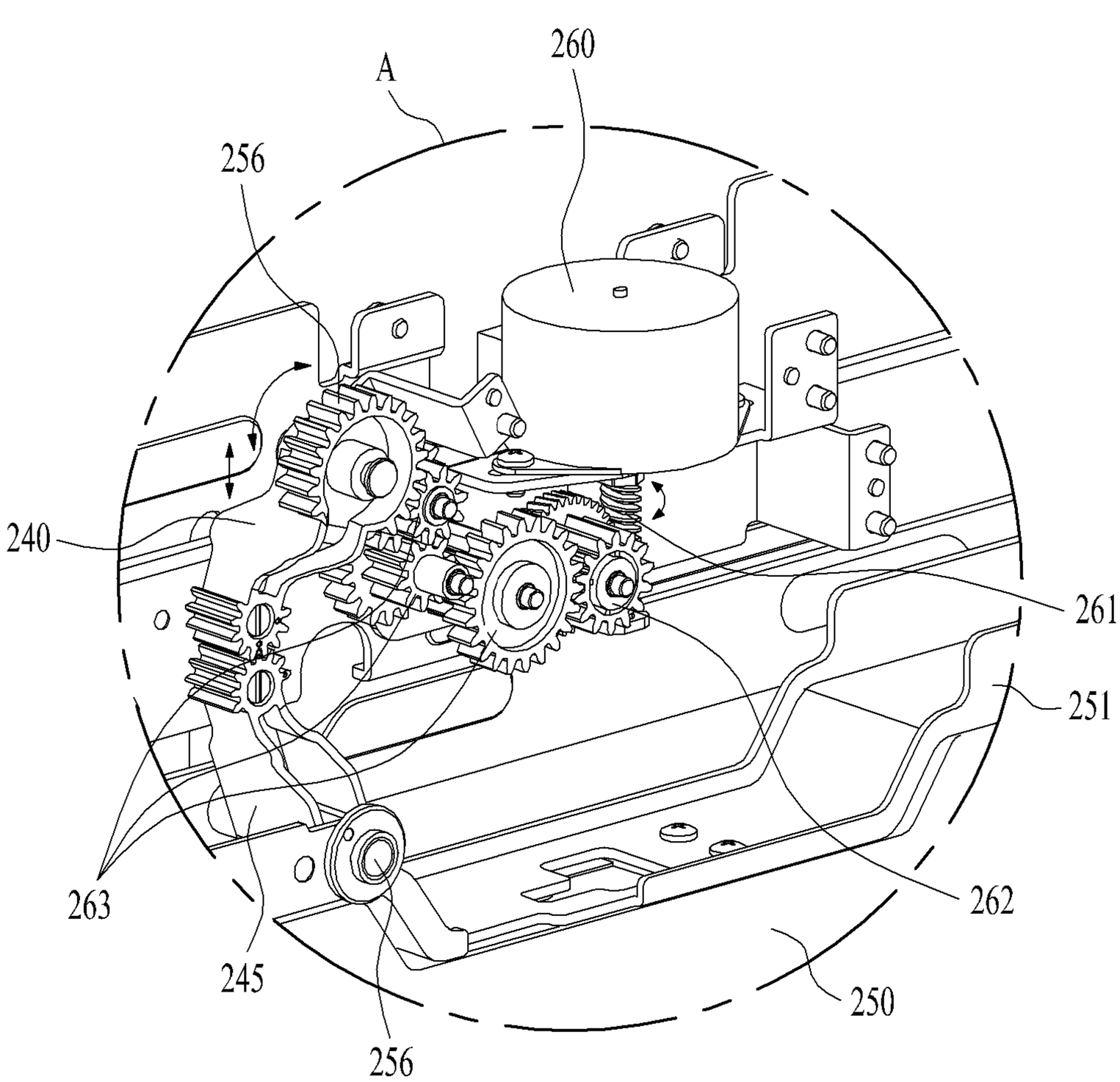

FIG. 12

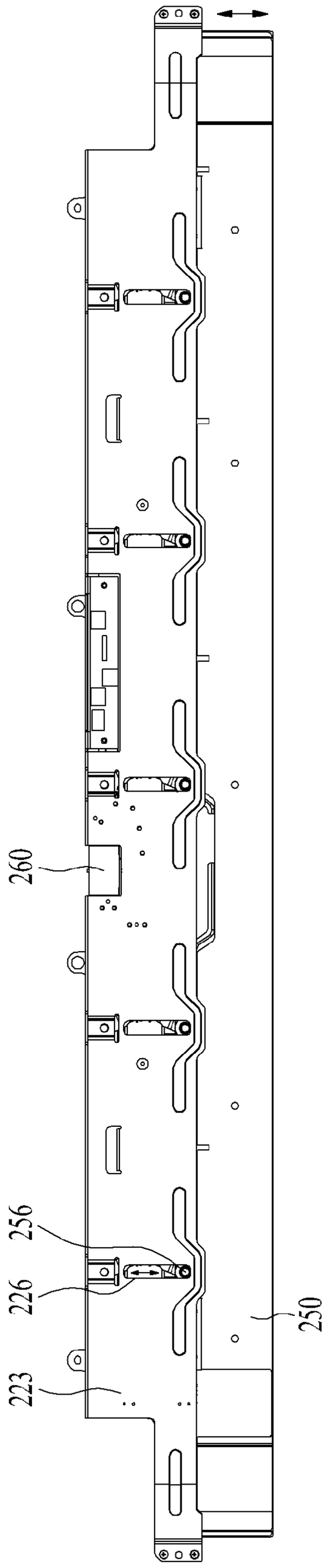

FIG. 13

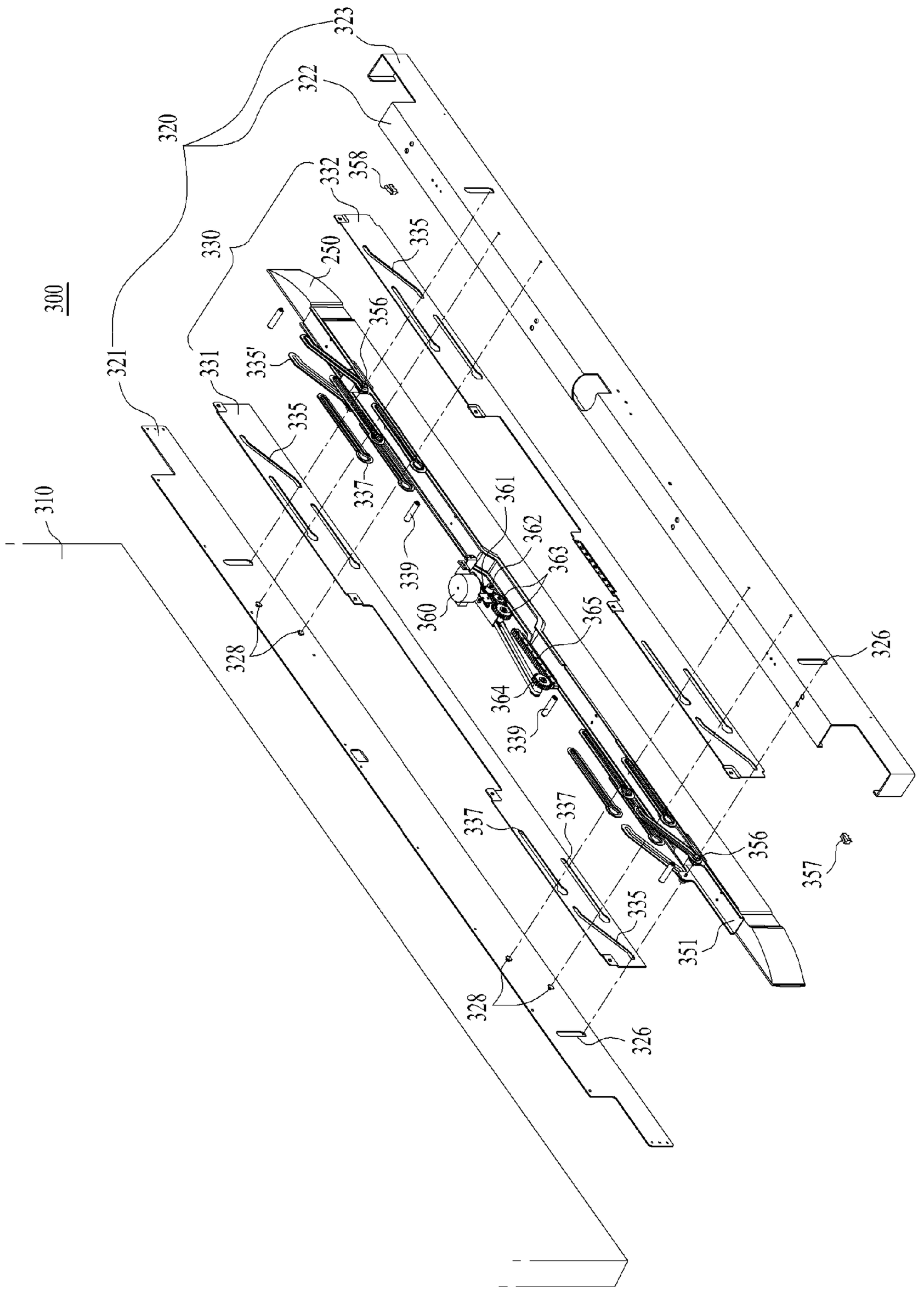
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FIG. 14

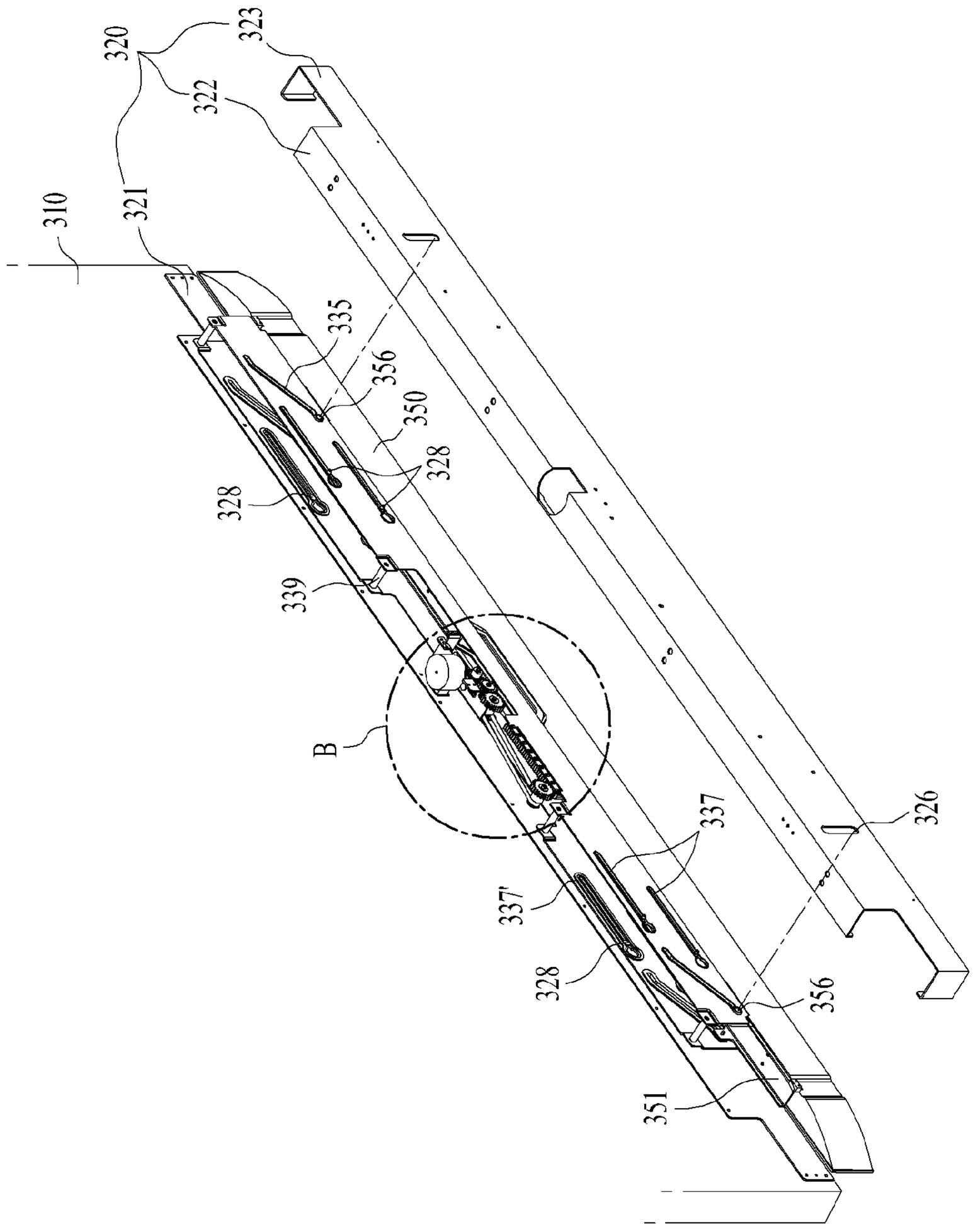
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FIG. 15

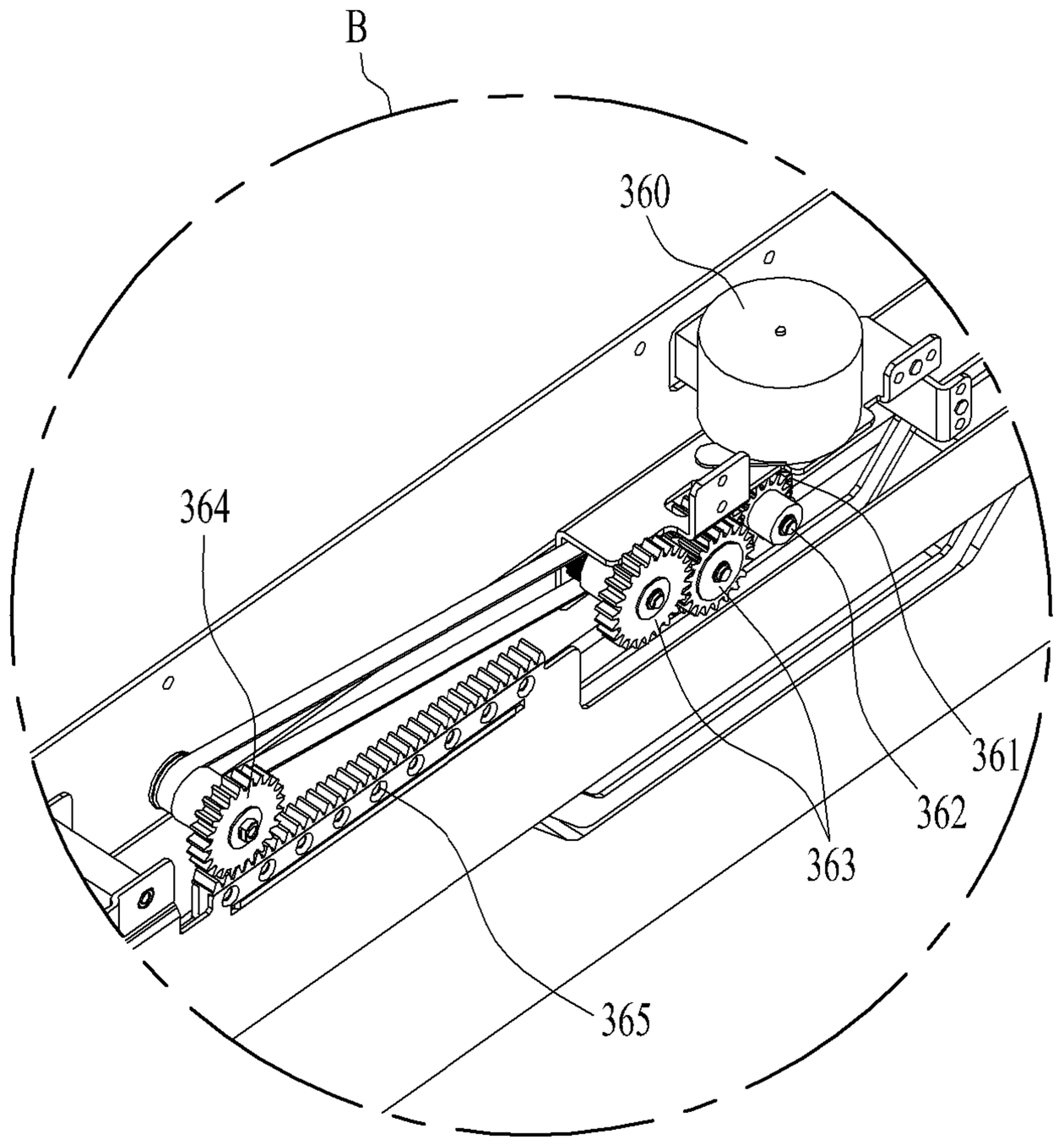


FIG. 16

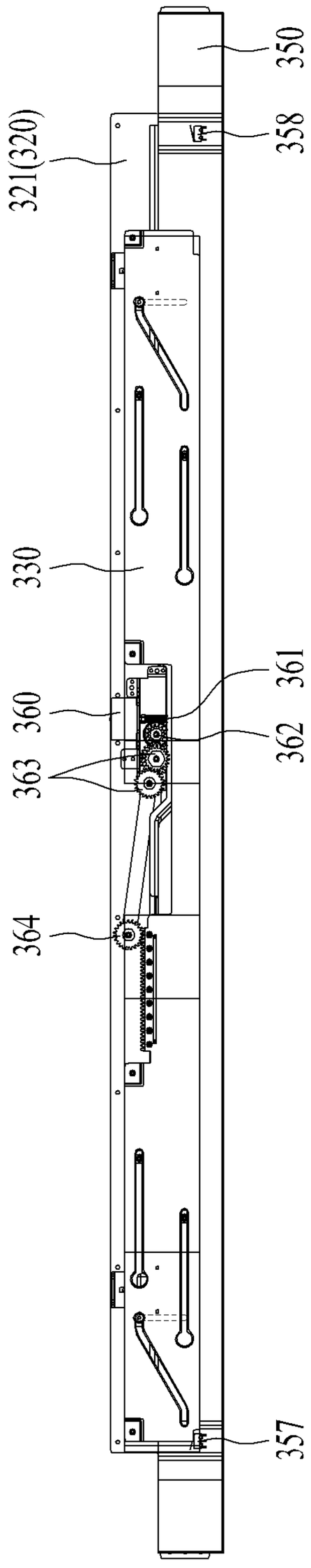
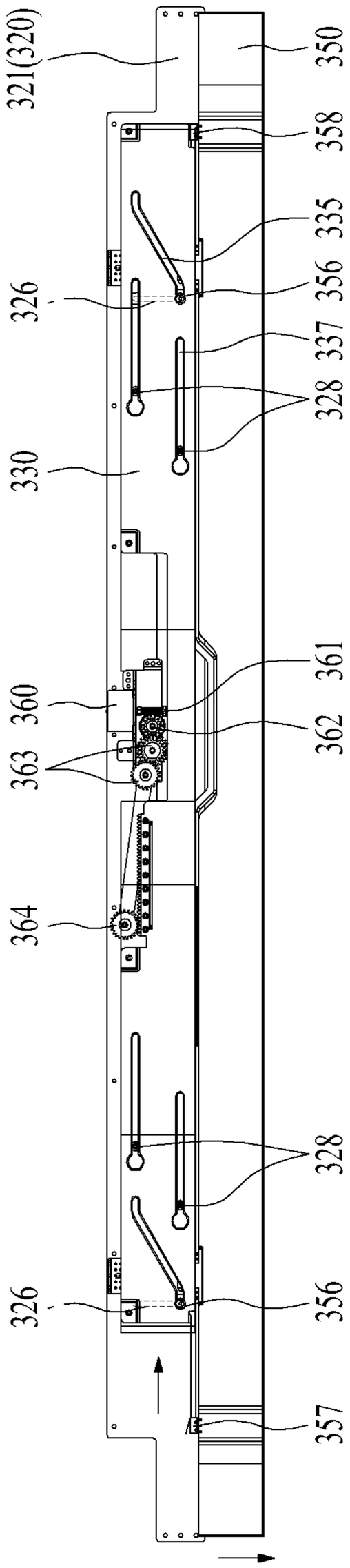


FIG. 17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SOUND APPARATUS

CROSS-REFERENCE TO RELATED APPLICATION

Pursuant to 35 U.S.C. §119(a), this application claims the benefit of the Korean Patent Application No. 10-2013-0052399, filed on May 9, 2013, which is hereby incorporated by reference as if fully set forth herein.

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a sound apparatus including a speaker module which vertically moves and is exposed at the front only when used.

Discussion of the Related Art

Sound apparatuses refer to devices including a speaker that radiates sound waves by converting an electric signal into vibration of a diaphragm to generate waves of condensation and rarefaction in the air. A display apparatus such as a large-size TV, which is equipped with a speaker as an essential constituent, has become one of sound apparatuses.

As slim TVs with a large screen have recently come into widespread use, importance of design of a neat front has increased. As such, speaker modules are now commonly installed so as not to be visible from the front of the TVs. Disposing the speaker at the side may decrease efficiency of transfer of sound to viewers, thereby resulting in performance degradation.

SUMMARY OF THE INVENTION

Accordingly, the present invention is directed to a sound apparatus that substantially obviates one or more problems due to limitations and disadvantages of the related art.

An object of the present invention is to provide a sound apparatus including a speaker module which vertically moves and is exposed at the front only when used.

Additional advantages, objects, and features of the invention will be set forth in part in the description which follows and in part will become apparent to those having ordinary skill in the art upon examination of the following or may be learned from practice of the invention. The objectives and other advantages of the invention may be realized and attained by the structure particularly pointed out in the written description and claims hereof as well as the appended drawings.

To achieve these objects and other advantages and in accordance with the purpose of the invention, as embodied and broadly described herein, a sound apparatus provided with a speaker vertically movable at a lower side includes a body, a bracket coupled to a lower portion of a rear surface of the body, a plurality of upper links, one end of each of the upper links being hinge-coupled to the bracket, a middle frame hinge-coupled to the other end of each of the upper links, a plurality of lower links, one end of each of the lower links being hinge-coupled to the middle frame, and at least one speaker module hinge-coupled to the other end of each of the lower links to vertically move according to rotational movement of the upper links and the lower links, wherein a direction of rotation of the upper link is opposite to a direction of rotation of the lower links, and the middle frame moves in a lateral direction during the rotational movement of the upper links and the lower links.

The sound apparatus may further include a first hinge gear coupled to the other end of each of the upper links and a second hinge gear coupled to the one end of each of the lower links, the first hinge gear and the second hinge gear rotating in engagement with each other t during rotation of the upper links and the lower links.

The sound apparatus may further include a damper adjoining at least one end of each of the upper links or the lower links to apply frictional force to reduce a rotational speed of the upper links and the lower links.

The sound apparatus may further include a guide to guide linear movement of the speaker module when the speaker module vertically moves.

The bracket may include a first bracket coupled to the rear surface of the body, and a second bracket protruding from an upper portion of the first bracket toward the rear surface of the body, wherein the guide may be a guide pole placed between the second bracket and an upper end of the speaker module, a length of the guide pole being variable.

The guide may include a vertical guide groove formed in the rear surface of the body or the bracket, and a guide protrusion protruding from an upper portion of the speaker module, the guide protrusion being inserted into the guide groove to move when the speaker module vertically moves.

The bracket may include a first bracket coupled to the rear surface of the body.

a second bracket protruding from an upper portion of the first bracket toward the rear surface of the body, a first coupling unit formed at the second bracket, and a second coupling unit positioned at an upper end of the speaker module, the second coupling unit being fastened to the first coupling unit when the speaker module moves upward and being released from the first coupling unit when the speaker module moves downward.

The first coupling unit and the second coupling unit may be provided with a push latch-type fastening structure fastened when pushed and separated when pushed again.

The bracket may include a first bracket coupled to the rear surface of the body, a second bracket protruding from an upper portion of the first bracket, and a third bracket protruding from the second bracket and positioned at a back of the speaker module, wherein the one end of each of the upper links may be fastened to the third bracket.

The sound apparatus may further include a motor to rotate at least one of the upper links to vertically move the speaker module.

The sound apparatus may further include a drive gear to rotate about a hinge coupled portion of the one end of each of the upper links, wherein the motor may rotate the drive gear.

The sound apparatus may further include a worm coupled to a shaft of the motor to rotate, a worm wheel engaged with the worm to rotate and adapted to transmit power to the drive gear.

The shaft of the motor may disposed perpendicular to the drive gear, and the worm wheel is coupled to the bracket such that a rotation axis of the worm wheel is parallel with a rotation axis the drive gear.

The sound apparatus may further include a connection gear interposed between the worm wheel and the drive gear to transmit rotational force of the worm wheel to the drive gear.

The sound apparatus may further include a first switch turned on when the speaker module is positioned at an upper portion, and a second switch turned on when the speaker module is positioned at a lower portion, wherein operation of the motor may be stopped when the first switch or the second switch is turned on.

The middle frame may be integrated with both the upper links and the lower links.

The body may include a display unit.

The sound apparatus may further include a tilting structure to adjust an angle between the body and the speaker module.

The at least one speaker module may include a plurality of speaker modules, wherein the number of speaker modules moving to a lower end may vary depending upon a kind of output sound.

In another aspect of the present invention, a sound apparatus provided with a speaker vertically movable at a lower side includes a body, a bracket coupled to a lower end of a rear surface of the body and provided with a vertical slot formed in a vertical direction, a speaker module provided, at an upper portion thereof, with a moving protrusion inserted into the vertical slot, the speaker module vertically moving according to movement of the moving protrusion along the vertical slot, a middle frame including an inclined slot, the moving protrusion being inserted into the inclined slot, and a drive unit to laterally move the middle frame, wherein, when the middle frame is laterally moved, the moving protrusion vertically moves along the vertical slot according to lateral movement of the inclined slot to vertically move the speaker module.

The drive unit may include a rack gear formed at the middle frame in a horizontal direction, and a pinion gear engaged with the rack gear to rotate, wherein the rack gear is laterally moved according to rotation of the pinion gear to laterally move the middle frame.

The drive unit may further include a motor to provide rotational force, a screw-shaped worm rotating according to rotation of the motor, a worm wheel engaged with the worm to rotate about a shaft of the motor arranged in a vertical direction, the worm rotating the pinion gear.

The sound apparatus may further include a connection gear arranged between the worm wheel and the pinion gear.

The middle frame may further include a horizontal slot, wherein the bracket is further provided with a guide protrusion inserted into the horizontal slot.

A length of the horizontal slot may be equal to or greater than a horizontal length of the inclined slot.

A height of the inclined slot may correspond to a length of the vertical slot.

According to at least one embodiment of the present invention, design of the front is enhanced by allowing the speaker module to be exposed forward only when needed, lateral twist or rocking of the speaker module may be minimized during movement of the speaker module.

Since the speaker module moves to the lower side of the body **310**, lateral arrangement of an additional space for the speaker is not needed. Accordingly, space utilization may be enhanced.

The effects obtainable from the present invention are not limited to the aforementioned effects. Other effects which are not mentioned above may be clear to those skilled in the art from the descriptions given below.

It is to be understood that both the foregoing general description and the following detailed description of the present invention are exemplary and explanatory and are intended to provide further explanation of the invention as claimed.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings, which are included to provide a further understanding of the invention and are incorporated in and constitute a part of this application, illustrate embodiment(s) of the invention and together with the description serve to explain the principle of the invention. In the drawings:

FIG. **1** is a front view illustrating a sound apparatus according to an exemplary embodiment of the present invention;

FIG. **2** is a rear view illustrating a speaker module of a sound apparatus positioned at an upper portion according to one embodiment;

FIG. **3** is a rear view illustrating a speaker module of a sound apparatus positioned at a lower portion according to one embodiment;

FIGS. **4** and **5** are perspective views illustrating an upper link and a lower link hinge-coupled to a middle frame of a sound apparatus according to one embodiment;

FIG. **6** is a perspective view illustrating a first coupling unit and a second coupling unit of a sound apparatus according to one embodiment;

FIG. **7** is an exploded perspective view illustrating a sound apparatus according to another embodiment of the present invention;

FIG. **8** is a perspective view illustrating a sound apparatus according to another embodiment, which is assembled;

FIG. **9** is a rear view illustrating a speaker module of a sound apparatus positioned at an upper portion according to another embodiment, in which a third bracket is omitted;

FIG. **10** is a rear view illustrating the speaker module of the sound apparatus positioned at a lower portion according to another embodiment, in which a third bracket is omitted;

FIG. **11** is an enlarged view illustrating portion A of FIG. **8**;

FIG. **12** is a rear view illustrating a speaker module of a sound apparatus positioned at a lower portion according to another embodiment;

FIG. **13** is an exploded perspective view illustrating a sound apparatus according to another embodiment;

FIG. **14** is a perspective view illustrating a sound apparatus according to another embodiment, which is assembled;

FIG. **15** is a rear view illustrating a speaker module of a sound apparatus positioned at an upper portion according to another embodiment;

FIG. **16** is a rear view illustrating a speaker module of a sound apparatus positioned at a lower portion according to another embodiment;

FIG. **17** is an enlarged view illustrating portion B of FIG. **13**.

DETAILED DESCRIPTION OF THE INVENTION

The present invention may have various modifications and embodiments. Specific embodiments are exemplarily shown in the accompanying drawings and a detailed description thereof will be given below. However, the present invention is not limited to the illustrated embodiments. It should be understood that the present invention covers all modifications, equivalents, or substitutes within the spirit and scope of the present invention.

Terms including ordinal numbers such as first, second, etc. may be used to explain various components, but the constituents are not limited thereto. These terms are used only for the purpose of distinguishing one constituent from another.

When one constituent is said to be "connected" or "linked" to another, it should be understood that this means the one constituent may be directly connected or linked to

another or another constituent may be interposed between the constituents. On the other hand, when one constituent is mentioned as being "directly connected" or "directly linked" to another, it should be understood that this means no other constituent is interposed between the constituents.

Terms used in this specification are merely adopted to explain specific embodiments, and are not intended to limit the present invention. A singular expression includes a plural expression unless context indicates otherwise. In this specification, "include" or "have" is intended to indicate that characteristics, figures, steps, operations, constituents, and components disclosed in the specification or combinations thereof exists. "Include" or "have" should be understood as not precluding existence of one or more other characteristics, figures, steps, operations, constituents, components, combinations thereof, or possibility of addition thereof.

Reference will now be made in detail to the preferred embodiments of the present invention, examples of which are illustrated in the accompanying drawings. Wherever possible, the same reference numbers will be used throughout the drawings to refer to the same or like parts.

FIG. **1** is a front view illustrating a sound apparatus **100** according to an exemplary embodiment of the present invention. A display apparatus may be an example of the sound apparatus **100**. When the display apparatus is in use, a speaker module **150** moves to the lower portion of the body **110**, at which a display unit is positioned and exposed at the front, as shown in FIG. **1**. When the display apparatus is not in use, the speaker module **150** moves to the upper portion of the body **110** and is thus positioned on the rear surface of the body **110** so as not to be exposed at the front.

A detailed description will be given of a stricture allowing vertical movement of the speaker module **150** with reference to FIGS. **2** to **6**. FIG. **2** is a rear view illustrating a speaker module **150** of a sound apparatus **100** positioned at an upper portion according to one embodiment of the present invention, and FIG. **3** is a rear view illustrating the speaker module **150** of the sound apparatus **100** positioned at a lower portion.

The sound apparatus **100** of this embodiment is a display apparatus. The sound apparatus **100** includes a body **110**, a bracket **120**, an upper link **140**, a lower link **145**, a middle frame **130**, and a speaker module **150**.

The upper link **140**, the lower link **145**, and the middle frame **130** are positioned between the body **110** and the speaker module **150**. When the upper link **140** and the lower link **145** rotate from the positions shown in FIG. **2**, the body **110** and the speaker module **150** move away from each other, and thus the speaker module **150** moves to the lower side of the body **110**. At this time, the middle frame **130** moves in a lateral direction according to rotation of the upper link **140** and the lower link **145**.

In the display apparatus, a display unit and a circuit part to control the speaker module **150** and the display unit are positioned at the body **110**, at which components of the sound apparatus **100** other than the speaker module **150** are installed.

As the importance of the design of the front surface of the display apparatus **100** increases, bezel size has decreased to minimize exposure of portions other than the display unit through the front surface, and the speaker is disposed so as not to be exposed through the front surface. In this embodiment, the speaker module **150** moves vertically to be exposed through the front surface only when in use.

The bracket **120** is coupled to the lower portion of the rear surface of the body **110**, and is fastened to the speaker module **150** such that the speaker module **150** is coupled to the body **110**. The components (the upper link **140**, the lower link **145**, the middle frame **130**, and the speaker frame **151**) to vertically move the speaker module **150** are positioned between the bracket **120** and the speaker module **150**. The bracket **120** may be formed of a rigid material such as SUS since it needs to support weight of the speaker module **150**.

The speaker module **150**, which serves to convert a sound signal into sound and outputs sound, uses a diaphragm, a magnet and a coil. When current according to the sound signal flows through the coil placed in the magnetic field of the magnet, mechanical force is applied to the coil according to the current, causing the diaphragm to move back and forth to produce sound.

While a speaker module **150** is exemplarily illustrated in FIGS. **2** and **3** as being arranged at the lower end of the body **110**, two or more speaker modules **150** may be provided to output stereo sound. The plural speaker module **150** may individually move up and down.

Herein, the number and kind of speakers of each speaker module may vary depending upon the kind of output sound. For example, only two speakers may be moved to the lower end and used as two-channel speakers in the case that a high quality of sound is not required as in viewing news, while more speakers may be used to form four or more-channel speakers when music is appreciated. In addition, the speaker module **150** may include a woofer. Thereby, 4.1 channel or 5.1 channel speakers may be implemented using the woofer.

One end of the upper link **140** is hinge-coupled to the bracket **120**, and the other end thereof is coupled to the middle frame **130**. One end of the lower link **145** is coupled to the middle frame **130**, and the other end thereof is coupled to the speaker module **150**. To couple the lower link to the speaker module **150**, a speaker frame **151** may be provided to the upper end of the speaker module **150**.

A tilting structure (not shown) may be arranged between the speaker module **150** and the speaker frame **151**. When the speaker module **150** is moved down to the lower portion, the tilting structure may be tilted forward, rearward, leftward, or rightward between the speaker frame **151** and the speaker module **150** to adjust the angle formed between the speaker module **150** and the body **110**.

For example, in the case that the display apparatus **100** is positioned at the upper side, the tilting structure may be tilted such that the speaker module **150** leans rearward with respect to the body **110**. In addition, in the case that three or more speaker modules **150** are provided, the left and right speakers may be tilted toward the center. Optimum sound may be implemented through the tilting structure.

A plurality of upper links **140** and a plurality of lower links **145** may be provided. Middle frames **130** interposed between the upper links **140** and the lower links **145** may be provided for the links, or a long middle frame **130** connected to the links may be used as shown in FIG. **2**. If there is a difference in the degree of rotation between the links, the speaker module **150** may tilt as it moves. Accordingly, the middle frame **130** connected to the entire links guides the links such that the links rotate to the same degree.

FIGS. **4** and **5** are perspective views illustrating an upper link **140** and a lower link **145** hinge-coupled to a middle frame **130** of a sound apparatus **100** according to one embodiment. In the case that the speaker module **150** is positioned at the upper portion, the upper link **140** and the lower link **145** are laterally disposed as shown in FIG. **4**. In the case that the speaker module **150** is positioned at the lower portion, the upper link **140** and the lower link **145** rotate as an angle therebetween increases, and the middle

frame **130** moves laterally as shown in FIG. **5**. At this time, the direction of rotation of the upper link **140** is opposite to that of the lower link **145**.

The other end of the upper link **140** and the one end of the lower link **145** may be coupled to the middle frame **130** while being spaced apart from each other, or may be coupled to the middle frame **130** to be adjacent to each other in order to contact each other when they rotate, as shown in FIGS. **4** and **5**.

To adjust the rotational speed, a damper **148** may be provided to the other end of the upper link **140** or the one end of the lower link **145**. The damper **148** is a member to reduce rotational speed using frictional force. As shown in FIG. **4**, the damper **148** is arranged to contact the other end of the upper link **140** or the one end of the lower link **145** to prevent the upper link **140** and the lower link **145** from quickly rotating to cause the speaker module **150** to quickly move downward.

A guide may be provided to allow vertical movement of the speaker module **150** during rotation of the upper link **140** and the lower link **145**. The guide prevents the speaker module **150** from laterally rocking while moving upward according to rotation of the upper link **140** and the lower link **145**.

For example, the guide may be configured, as shown in FIG. **3**, with a guide groove **126** vertically formed in the bracket **120**, and a guide protrusion **156** protruding from the upper front surface of the speaker module **150** to vertically move along the guide groove **126**. The guide groove **126** may be directly formed on the rear surface of the body **110**.

As another example of the guide, a guide pole **153** arranged between the bracket **120** and the speaker module **150** may be used. The bracket **120** includes a first bracket **121** coupled to the rear surface of the body **110** and a second bracket **122** protruding from the upper end of the bracket **120** toward the rear surface of the body **110**. One end of the guide pole **153** is coupled to the second bracket **122**, and the other end thereof is coupled to the upper end of the speaker module **150**. The length of the guide is varied to control vertical movement of the speaker module **150**.

In this embodiment, a fastening part **160** may be provided to fix the speaker module **150** when the speaker is moved to the upper portion. FIG. **6** is a perspective view illustrating a first coupling unit **161** and a second coupling unit **162** of a sound apparatus **100** according to one embodiment. In FIG. **6**, the fastening part **160** is configured with the first coupling unit **161** and the second coupling unit **162**.

The first coupling unit **161** is formed on the second bracket **122** to face downward. The second coupling unit **162** is positioned at the upper end of the speaker module **150** such that the second coupling unit **162** is fastened to the first coupling unit **161** when the speaker module **150** moves to the upper portion, and is released from the first coupling unit **161** when the speaker module moves to the lower portion.

As shown in FIG. **6**, a push latch-type fastening structure causing the portions to be fastened to and separated from each other by push may be provided. That is, when a user raises and pushes the speaker module **150** to couple the first coupling unit **161** to the second coupling unit **162**, the speaker module **150** is fixed to the upper portion. When the user pushes the speaker module **150** again, the push latch-type fastening structure is separated, and the speaker module **150** is lowered by weight of the speaker module **150**.

At this time, by controlling the rotational speed of the hinged portions of the upper link **140** and the lower link **145**, the speed of lowering of the speaker module **150** is adjusted. The rotational speed of the hinged portions may be adjusted by arranging a gear between the upper link **140** and the lower link **145** or fitting a silicone member between the upper link **140** and the lower link **145** to increase frictional force. The rotational speed may be additionally controlled using the damper **148**.

According to this embodiment, the speed of vertical movement of the speaker module **150** is adjusted using the upper link **140** and the lower link **145**, and the speaker module **150** is fixed to the upper portion through the fastening part **160**. Thereby, the speaker module **150** may be exposed forward only when it is vertically moved at the lower portion of the body **110** for use. In this embodiment, a user manually pushes up the speaker module **150** to cause vertical movement of the speaker module **150** and controls fastening of the fastening part **160**.

In the configuration of the illustrated embodiment, vertical movement of the speaker module **250** may be automatically controlled using a motor **260** that controls vertical movement of the speaker module **250**. Hereinafter, an embodiment of automatically controlling vertical movement of the speaker module **250** will be described in detail with reference to FIGS. **7** to **14**.

FIG. **7** is an exploded perspective view illustrating a sound apparatus **200** according to another embodiment of the present invention, and FIG. **8** is a perspective view illustrating the sound apparatus **200** according to another embodiment, which is assembled. Referring to FIGS. **7** and **8**, the sound apparatus **200** includes a body **210**, a bracket **220**, an upper link **240**, a lower link **245**, a speaker module **250** and a motor **260**.

A display unit and a circuit part to control the speaker module **250** and the display unit are positioned at the body **210**, at which components of the sound apparatus **100** other than the speaker module **250** are installed.

The bracket **220** is coupled to the lower portion of the rear surface of the body **210** and connected to the speaker module **250** through the upper link **240** and the lower link **245** such that the speaker module **250** is vertically movable with respect to the body **210**. In this embodiment, the bracket **220** includes a first bracket **221**, which is coupled to the rear surface of the body **210**, a second bracket **222** protruding from the upper end of the first bracket **221** toward the rear surface of the body **210** and a third bracket **223** provided to the second bracket **222** and positioned on the rear surface of the speaker module **250**.

The first bracket **221** is coupled to the rear surface of the body **210**. The second bracket **222** connects the third bracket **223**, which covers the back of the speaker module **250** to the first bracket **221**, and covers the upper portion of the speaker module **250**. The third bracket **223** prevents the speaker module **250** from being exposed outside by covering the back of the speaker module **250**. In this embodiment, one end of the upper link **240** is coupled to the third bracket **223**.

As in the previous embodiment, both ends of the upper link **240** are hinge-coupled to the bracket **220** and the middle frame **230**, while both ends of the lower link **245** are hinge-coupled to the middle frame **230** and the speaker module **250**. The upper portion of the speaker module **250** may be provided with a speaker frame **251** to be fastened to the lower link **245**, the speaker frame **251** may be formed in a bracket shape by being bent upward from the front and rear surfaces of the speaker module **250**. A hinge shaft hinge-coupled to the other end of the lower link **245** may be provided in the bracket-shaped speaker frame **251**.

According to this embodiment, the speaker module **250** is vertically moved by rotation of the upper link **240**, which is controlled by the motor **260**. Accordingly, by providing a

hinge gear **243** between the other end of the upper link **240** and the one end of the lower link **245** such that the lower link **245** rotates according to the rotational speed of the upper link **240**, the rotational speed of the upper link **240** and the lower link **245** may be kept constant.

FIG. **9** is a rear view illustrating a speaker module **250** of a sound apparatus **200** positioned at an upper portion according to another embodiment, in which the third bracket **223** is omitted, and FIG. **10** is a rear view illustrating the speaker module **250** positioned at a lower portion, in which the third bracket **223** is omitted.

In FIG. **9**, the lower link **245** covered by the speaker module **250** is not shown. The upper link **240** and the lower link **245** are arranged in the lateral direction such that one end of the upper link **240** is adjacent to the other end of the lower link **245**.

In this case, the angle between the upper link **240** and the lower link **245** increase as the links rotate in the opposite directions. The speaker module **250** moves downward when the middle frame **230** moves in the lateral direction, as shown in FIG. **10**.

In the illustrated embodiment, rotation of the upper link **240** is controlled by the motor **260**. FIG. **11**, which is a partially enlarged view of the motor **260** of FIG. **8**, shows the motor **260**, the upper link **240**, and gears **261**, **262**, **263** and **265** positioned between the motor **260** and the upper link **240**.

The motor **260** rotates about an axis of rotation when electricity is applied thereto. The rotating part of the motor **260** may serve as a hinge shaft hinge-coupled to one end of the upper link **240** to control the rotational speed of the upper link **240**. In this case, however, the shaft of the motor **260** is disposed in the front-back direction, resulting in increase of thickness of the structure.

Therefore, in order not to increase the thickness of the structure coupled to the back of the body **210** to allow vertical movement of the speaker module **250**, the shaft of the motor **260** may be disposed in a direction perpendicular to the direction of arrangement of the hinge-coupling axle of the upper link **240**. The shaft of the motor **260** may be disposed to face downward as shown in FIG. **11**, or may be disposed to face in the upward direction or lateral direction.

Since the shaft of the motor **260** is perpendicular to the hinge-coupling axle of the upper link **240**, a worm **261** and a worm wheel **262** are provided to transmit rotational force of the motor **260** from the motor **260** to the hinge at one end of the upper link **240**. The worm **261**, which is a screw-shaped gear, is fitted to the rotating part of the motor **260** such that it rotates. The threads of the worm **261** are engaged with the teeth of the worm wheel **262**. Accordingly, when the motor **260** rotates, the worm wheel **262** also rotates. Using the worm **261** and the worm wheel **262**, the shaft may be arranged at the right angle.

The hinge-coupled portion of one end of the upper link **240** is provided with a drive gear **265**. The drive gear **265** is rotated by rotational force transmitted from the motor **260** to control rotation of the upper link **240**. Herein, the worm wheel **262** and the drive gear **265** coupled to the upper end of the upper link **240** are not positioned in the same plane, and the worm wheel **262** is spaced apart from the drive gear **265**, as shown in FIG. **11**. Accordingly, at least one connection gear **263** may be interposed between the worm wheel **262** and the drive gear **265** to transmit rotational force of the worm wheel **262**.

The drive gear **265** only needs to be provided to one of a plurality of upper links **240**. As shown in FIG. **10**, when one of the upper links **240** rotates, the other upper links **240** are also rotated by the middle frame **230** at the same speed as the upper link **240** provided with the drive gear **265**. Accordingly, the vertical movement of the speaker module **250** may be controlled by one motor **260**, rather than by plural motors **260**.

Since the rotational speed of the upper link **240** is controlled according to the rotational speed of the motor **260**, the speaker module **250** may be prevented from falling at high speed and allowed to vertically move at a constant speed.

Switches **257** and **258** may be provided to control operation of the motor **260** such that the motor **260** does not operate any more once movement of the speaker module **250** is completed. FIGS. **9** and **10** show a first switch **257** and a second switch **258**. The first switch **257** is pushed and turned on by the speaker module **250** when the speaker module **250** is positioned at an upper portion. The second switch **258** is pushed and turned on by the speaker module **250** when the speaker module **250** is positioned at a lower portion.

When the user turn on the sound apparatus **200** using a remote control to lower the speaker module **250**, the motor **260** is driven and the first switch **257** pushed by the speaker module **250** switches from the ON state to OFF state at it is released from the pushing force. In addition, the speaker module **250** moves downward and pushes the second switch **258** to be switched from OFF state to ON state, as shown in FIG. **10**. When the second switch **258** is turned on, operation of the motor **260** is stopped.

On the other hand, when electricity applied to the sound apparatus **200** is cut off, the motor **260** operates to move the speaker module **250** positioned at the lower portion to an upper portion. Thereby, the speaker module **250** begins to move upward. Once the second switch **258** is turned off and upward movement of the speaker module **250** is completed, the first switch **257** is pushed and turned on by the speaker module **250**, and operation of the motor **260** is stopped.

FIG. **12** is a rear view illustrating the speaker module **250** positioned at a lower portion, in which the third bracket **223** covers the back of the speaker module **250**. Referring to FIG. **12**, a guide groove **226** is shown, and a guide protrusion **256** protruding from the speaker module **250** is inserted into the guide groove **226** to guide the speaker module **250** such that the speaker module **250** moves vertically without rocking laterally.

Referring to FIG. **7**, the guide protrusion **256** may function as a hinge shaft of the lower link **245** coupled to the speaker module **250**. As shown in FIG. **7**, the guide groove **226**, vertically extending a long distance, may be formed in both the first bracket **221** and the third bracket **223**, and the guide protrusion **256** may be formed on both front and rear surfaces of an upper portion of the speaker module **250**.

FIG. **13** is an exploded perspective view illustrating a sound apparatus **300** according to another embodiment, and FIG. **14** is a perspective view illustrating the sound apparatus **300**, which is assembled. Referring to FIGS. **13** and **14**, the sound apparatus **300** includes a body **310**, a bracket **320**, a middle frame **330**, a speaker module **350**, and a motor **360**.

A display unit and a circuit part to control the speaker module **350** and the display unit are positioned at the body **310**, at which components of the sound apparatus **300** other than the speaker module **350** are installed.

The bracket **320** is coupled to the lower portion of the rear surface of the body **310**. In this embodiment, the bracket **320** includes a first bracket **321**, which is coupled to the rear surface of the body **310**, a second bracket **322** protruding from the upper end of the first bracket **321** toward the rear

surface of the body **310**, and a third bracket **323** provided to the second bracket **322** and positioned on the back of the speaker module **350**.

The bracket **320** includes a vertical slot **326**. A moving protrusion **356** protruding from the speaker module **350** is inserted into the vertical slot **326**. The moving protrusion **356** vertically moves along the vertical slot **326** to vertically move the speaker module **350**.

The vertical slot **326** only needs to be formed in any one of the first bracket **321**, which is coupled to the back of the body **310**, and the third bracket **323**, which is positioned on the back of the speaker module **350**. Preferably, the vertical slot **326** is formed in both the first bracket **321** and the second bracket **322**, as shown in FIGS. **13** and **14**, to ensure that the speaker module **350** stably moves vertically without rocking.

As described in a previous embodiment, the speaker module **350** is positioned on the back of the body **310** when it is not vertically moved at the lower end of the body **310**, and is exposed at the lower portion of the body **310** when it is in use. When the moving protrusion **356** protruding from the upper portion of the speaker module **350** moves along the vertical slot **326** of the bracket **320** as discussed above, the speaker module **350** also vertically moves.

A speaker frame **351** may be further provided to the upper portion of the speaker module **350**, and the moving protrusion **356** may be formed at the speaker frame **351**. The speaker frame and the moving protrusion **356** may be made of a rigid material such as metal or reinforced plastics in order that they are not damaged when subjected to weight of the speaker.

In this embodiment, the middle frame **330** having an inclined slot **335** is used to apply force to a guide pole to vertically move the moving protrusion **356** along the vertical slot **326**. The moving protrusion **356** is inserted into the inclined slot **335**. When the middle frame **330** moves in a horizontal direction, the moving protrusion **356** moves along the inclined slot **335**.

The pattern of movement of the moving protrusion **356** along the inclined slot **335** and the vertical slot **326** will be described in more detail with reference to FIGS. **15** and **16**. FIG. **15** is a rear view illustrating a speaker module **350** of a sound apparatus **300** positioned at an upper portion and a drive unit according to another embodiment, and FIG. **16** is a rear view illustrating the speaker module **350** of a sound apparatus **300** positioned at a lower portion.

In this embodiment, the inclined slot **335** is inclined to rise up as it extends from the left to the right in the figures. The inclined slot **335** may be arranged in the opposite manner. The moving protrusion **356** is inserted into the inclined slot **335** and the vertical slot **326**, along which the protrusion moves.

When the middle frame **330** moves from the position shown in FIG. **15** to the right side and reaches the position shown in FIG. **16**, the moving protrusion **356** is positioned at the upper end of the inclined slot **335** in the case that the speaker module **350** is positioned at an upper portion, and is positioned at the lower end of the inclined slot **335** in the case that the speaker module **350** is positioned at a lower portion. According to movement of the middle frame **330**, the moving protrusion **356** moves along the inclined slot **335**.

In this embodiment, the middle frame serves to directly transmit force through the motor. Accordingly, two middle frames **331** and **332** may be used to stably support load. The two middle frames **331** and **332** are coupled to each other through a fastening member **339**. Thereby, when force is applied to one middle frame **332** of the two middle frames, the other middle frame **331** moves together.

Since the moving protrusion **356** moves along the inclined slot **335**, it may be seen to move upward and laterally. However, horizontal movement is conducted by the middle frame **330**, and thus the moving protrusion **356** actually moves only in the vertical direction. The vertical movement of the moving protrusion **356** is made along the vertical slot **326** formed in the bracket **320**.

The middle frame **330** may further include a horizontal slot **337** to ensure that the middle frame **330** stably move without vertically moving during in lateral movement. A guide protrusion **328** protruding from the bracket **320** is inserted into the horizontal slot **337**. Thereby, the middle frame **330** moves only in the horizontal direction relative to the bracket **320**.

The horizontal slot **337** of the first bracket **321** is inserted into the horizontal slot **337** of the front middle frame **331**, and a guide protrusion (not shown) of the third bracket **321** is inserted into the horizontal slot **337** of the rear middle frame **332**. Thereby, horizontal movement of the middle frame **330** is guided.

When the middle frame **330** horizontally moves, the inclined slot **335** moves. Accordingly, the moving protrusion **356** is subjected to force in a vertical direction during movement along the inclined slot **335**, and thus vertically moves along the vertical slot **326**, causing the speaker module **350** to vertically move.

Since the moving protrusion **356** and the guide protrusion **328** subjected to load acting downward are inserted into moved along the inclined slot **335** and the horizontal slot **326** formed in the middle frame **330**, the slots may be worn and deformed. To prevent this, reinforcement slots **335'** and **337'** are attached to the inclined slot **335** and the horizontal slot **326** to assist the inclined slot **335** and the horizontal slot **326**.

FIG. **17** is an enlarged perspective view of the motor **360**. The motor **360** is a device to apply driving force to the middle frame **330**. A rack gear **365** and a pinion gear **364** may be used to apply rotational force to cause the middle frame **330** to linearly move. The rack gear **365** is a linear gear with teeth, and the pinion gear **364** is a disc-shaped gear with teeth engaged with those of the rack gear **365**.

To apply rotational force to the pinion gear **364**, the motor **360** may be provided with a worm **361** and a worm wheel **362**, as in the previous embodiment. The worm **361** and the worm wheel **362** converts rotation about the shaft of the motor **360**, which is vertically disposed, into rotation about a shaft arranged in a horizontal direction (see FIGS. **15** and **16**).

That is, when the motor **360** rotates, the worm **361** rotates, and accordingly the worm wheel **362** engaged with the worm **361** also rotates. A connection gear **363** may be used to transmit the rotational force of the worm wheel **362** to the pinion gear **364**. When the pinion gear **364** rotates, the rack gear **365** moves in a horizontal direction, and the middle frame **330** laterally moves. In FIG. **15**, the pinion gear **364** is positioned on the right side of the rack gear **365**. In FIG. **16**, the pinion gear **364** is positioned on the left side of the rack gear **365**. That is, the rack gear **365** laterally moves according to rotation of the pinion gear **364**, and the middle frame **330** in turn laterally moves.

When the user turns on/off the sound apparatus **300**, the motor **360** may start to operate. Once movement of the speaker module **350** to the lower end or upper end is completed, operation of the motor **360** is stopped. In the case that movement of the speaker module **350** to the lower end is completed, a first switch **357** is turned on. In the case that

movement of the speaker module **350** to the upper end is completed, a second switch **358** is turned on. Thereby, operation of the motor **360** is stopped. While the switches **257** and **258** of the previous embodiment are disposed at positioned where they are pushed by the vertically moving speaker module **250**, the switches **357** and **358** of this embodiment are disposed on the left and right sides of the middle frame **330** such that the middle frame **330** pushes the switches **357** and **358**.

That is, in the case that movement of the speaker module **350** to an upper portion is completed as shown in FIG. **15**, the middle frame **330** moves to the left side, pushing the first switch **357** to stop operation of the motor **360**. On the other hand, in the case that movement of the speaker module **350** to an lower portion is completed as shown in FIG. **16**, the middle frame **330** moves to the right side, pushing the second switch **358** to stop operation of the motor **360**.

As discussed above, according to at least one embodiment of the present invention, design of the front is enhanced by allowing the speaker module to be exposed forward only when needed, lateral twist or rocking of the speaker module may be minimized during movement of the speaker module.

Since the speaker module moves to the lower side of the body **310**, lateral arrangement of an additional space for the speaker is not needed. Accordingly, space utilization may be enhanced.

It will be apparent to those skilled in the art that various modifications and variations can be made in the present invention without departing from the spirit or scope of the inventions.

Therefore, the detailed described given above should be understood as being illustrative rather than limiting in all aspects. The scope of the invention should be determined by reasonable interpretation of the appended claims, and the present invention covers the modifications and variations of this invention provided they come within the scope of the appended claims and their equivalents.

What is claimed is:

1. A sound apparatus provided with a speaker vertically movable at a lower side comprising:

a body;

a bracket coupled to a lower portion of a rear surface of the body;

a plurality of upper links, one end of each of the upper links being hinge-coupled to the bracket;

a middle frame hinge-coupled to the other end of each of the upper links;

a plurality of lower links, one end of each of the lower links being hinge-coupled to the middle frame; and

at least one speaker module hinge-coupled to the other end of each of the lower links to vertically move according to rotational movement of the upper links and the lower links,

wherein a direction of rotation of the upper links is opposite to a direction of rotation of the lower links, and the middle frame moves in a lateral direction during the rotational movement of the upper links and the lower links.

2. The sound apparatus according to claim **1**, further comprising a first hinge gear coupled to the other end of each of the upper links and a second hinge gear coupled to the one end of each of the lower links, the first hinge gear and the second hinge gear rotating in engagement with each other during rotation of the upper links and the lower links.

3. The sound apparatus according to claim **1**, further comprising a damper adjoining at least one end of each of the upper links or the lower links to apply frictional force to reduce a rotational speed of the upper links and the lower links.

4. The sound apparatus according to claim **1**, further comprising a guide to guide linear movement of the speaker module when the speaker module vertically moves.

5. The sound apparatus according to claim **4**, wherein the bracket comprises a first bracket coupled to the rear surface of the body, and a second bracket protruding from an upper end of the first bracket toward the rear surface of the body,

wherein the guide is a guide pole placed between the second bracket and an upper end of the speaker module, a length of the guide pole being variable.

6. The sound apparatus according to claim **4**, wherein the guide comprises:

a vertical guide groove formed in the rear surface of the body or the bracket; and

a guide protrusion protruding from an upper portion of the speaker module, the guide protrusion being inserted into the guide groove to move when the speaker module vertically moves.

7. The sound apparatus according to claim **1**, wherein the bracket comprises a first bracket coupled to the rear surface of the body, a second bracket protruding from an upper end of the first bracket, and a third bracket protruding from the second bracket and positioned at a back of the speaker module,

wherein the one end of each of the upper links is fastened to the third bracket.

8. The sound apparatus according to claim **1**, further comprising a motor to rotate at least one of the upper links to vertically move the speaker module.

9. The sound apparatus according to claim **8**, further comprising a drive gear to rotate about a hinge coupled portion of the one end of each of the upper links,

wherein the motor rotates the drive gear.

10. The sound apparatus according to claim **8**, further comprising:

a worm coupled to a shaft of the motor to rotate;

a worm wheel engaged with the worm to rotate and adapted to transmit power to the drive gear.

11. The sound apparatus according to claim **10**, wherein:

the shaft of the motor is disposed perpendicular to the drive gear; and

the worm wheel is coupled to the bracket such that a rotation axis of the worm wheel is parallel with a rotation axis the drive gear.

12. The sound apparatus according to claim **10**, further comprising a connection gear interposed between the worm wheel and the drive gear to transmit rotational force of the worm wheel to the drive gear.

13. The sound apparatus according to claim **8**, further comprising a first switch turned on when the speaker module is positioned at an upper portion; and

a second switch turned on when the speaker module is positioned at a lower portion,

wherein operation of the motor is stopped when the first switch or the second switch is turned on.

14. The sound apparatus according to claim **1**, wherein the middle frame is integrated with both the upper links and the lower links.

15. The sound apparatus according to claim **1**, wherein the body comprises a display unit.

16. The sound apparatus according to claim **1**, further comprising a tilting structure to adjust an angle between the body and the speaker module.

17. The sound apparatus according to claim 1, wherein the at least one speaker module includes a plurality of speaker modules,

wherein the number of speaker modules moving to a lower end varies depending upon a kind of output sound.

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